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(54) **MINIATURE CIRCUIT BREAKER**

(57) The present invention relates to a miniature circuit breaker including: a housing; a control circuit board, provided in the housing; an operating mechanism including a handle, a latch, a trip bar, and a contact support frame for supporting the latch and the trip bar; a first phase circuit including a first wiring terminal and a first stationary contact that are connected, a first movable contact connected to the contact support frame, and a second wiring terminal; a second phase circuit comprising a third wiring terminal and a second stationary contact that are connected, a second movable contact connected to the contact support frame, and a fourth wiring terminal connected to the second movable contact; a closing actuating mechanism, connected to the control circuit board and drives the operating mechanism; a first current detection device, configured to detect a current of the first stationary contact, and connected to the control circuit board; a second current detection device, configured to detect a current of the second wiring terminal and the fourth wiring terminal, and connected to the control circuit board; and an opening actuating mechanism, connected to the second wiring terminal and the control circuit board, and configured to drive the trip bar to be unlocked from the latch based on current information detected by the first current detection device and the second current detection device.

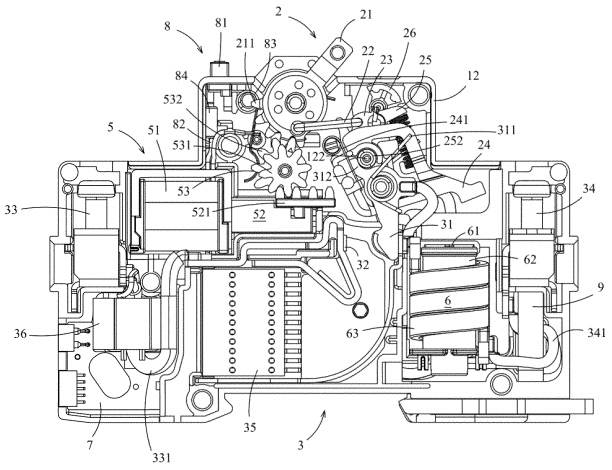


FIG. 4

EP 4 235 728 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of circuit protection, and in particular to a miniature circuit breaker.

BACKGROUND

[0002] Existing miniature circuit breakers (MCB) usually only have shortcircuit and overload protection functions, and this kind of conventional MCBs cannot meet use requirements in some scenarios requiring leakage protection or remote operation. A current solution is to connect the MCB to other functional devices (e.g., a remote operating switch, or a residual current operated circuit breaker (RCBO)), etc., so as to form a circuit breaker capable of meeting various functional needs. However, such an assembled circuit breaker usually has a relatively large volume, particularly with a relatively large thickness, and thus cannot meet current miniaturization requirements for electrical elements. In addition, during assembly of said circuit breaker, individual functional devices need to be connected together, and it is necessary to note the wire connection order during the process, and once a wire connection error occurs, there may be an irreparable loss for the entire circuit. This kind of complex assembly procedure is relatively time consuming and laborious.

[0003] Therefore, there is a need in the industry for designing a miniature circuit breaker with a simple structure, a small volume and simple wire connection.

SUMMARY

[0004] The present invention aims to provide a miniature circuit breaker capable of solving at least part of the above-mentioned technical problems.

[0005] According to one aspect of the present invention, provided is a miniature circuit breaker, comprising: a housing, defining an interior space; a control circuit board, disposed in the interior space; an operating mechanism comprising a handle, a latch connected to the handle, a trip bar capable of being locked with or unlocked from the latch, and a contact support frame supporting the latch and the trip bar; a first phase circuit comprising a first wiring terminal, a first stationary contact electrically connected to the first wiring terminal, a first movable contact pivotally connected to the contact support frame, and a second wiring terminal; a second phase circuit comprising a third wiring terminal, a second stationary contact electrically connected to the third wiring terminal, a second movable contact pivotally connected to the contact support frame, and a fourth wiring terminal electrically connected to the second movable contact; a closing actuating mechanism, electrically connected to the control circuit board and connected to and driving the operating mechanism; a first current detection device, configured to detect a current flowing through the first stationary contact, and electrically connected to the control circuit board; a second current detection device, configured to detect a current flowing through the second wiring terminal and the fourth wiring terminal, and electrically connected to the control circuit board; and an opening actuating mechanism, electrically connected to the second wiring terminal and the control circuit board, and configured to selectively drive the trip bar to be unlocked from the latch based on current information detected by the first current detection device and the second current detection device.

[0006] In some implementations, the first wiring terminal is connected to the first stationary contact by means of a wire, and the first current detection device is a first current transformer sleeved on the wire.

[0007] In some implementations, the second wiring terminal is connected to the opening actuating mechanism by means of a wire, the fourth wiring terminal is connected to the second movable contact by means of a wire, and the second current detection device is a second current transformer sleeved on the two wires.

[0008] In some implementations, the opening actuating mechanism comprises: an opening armature, movably mounted in the interior space of the housing; and a first opening coil, surrounding the opening armature and electrically connected to the control circuit board; wherein the control circuit board is configured to control the opening armature to move based on current conditions detected by the first current detection device and/or the second current detection device, so as to drive the trip bar to be unlocked from the latch.

[0009] In some implementations, the opening actuating mechanism comprises: an opening armature, movably mounted in the interior space of the housing; and a second opening coil, surrounding the opening armature and electrically connected to the second wiring terminal, wherein the second opening coil drives the opening armature to move based on current conditions, so as to drive the trip bar to be unlocked from the latch.

[0010] In some implementations, the housing comprises a first half housing and a second half housing disposed opposite to each other, and an intermediate casing located between the first half housing and the second half housing, and the closing actuating mechanism is supported by the intermediate casing and comprises: a closing coil, disposed at the intermediate casing; and a closing armature, movably passing through the closing coil and connected to and driving the handle.

[0011] In some implementations, the control circuit board is secured to the intermediate casing at a location adjacent to the first wiring terminal and the first current detection device, and a clearance opening corresponding to the first current detection device is formed in the intermediate casing.

[0012] In some implementations, the contact support frame is pivotally mounted on the housing, and the first

movable contact and the second movable contact are pivotally mounted on the contact support frame, wherein overtravel of the first movable contact is less than overtravel of the second movable contact, and an arc extinguishing chamber corresponding to the first stationary contact is arranged in the interior space.

[0013] In some implementations, the operating mechanism further comprises an indicator plate pivotally mounted on the housing, the indicator plate has an arc-shaped slot, and a connecting pin pivotally connecting the latch to the contact support frame is inserted in the arc-shaped slot and is movable in the arc-shaped slot.

[0014] In some implementations, the miniature circuit breaker further comprises a test assembly, and the test assembly comprises: a button, movably mounted at the housing; and a conductive structure, provided on the button and electrically connected to the fourth wiring terminal; and a resistor, electrically connected to the control circuit board and the first wiring terminal; wherein when the button is moving towards the housing, the conductive structure is capable of being electrically connected to the resistor.

[0015] Part of the other features and advantages of the present invention would be obvious to those skilled in the art after reading the present application, and the rest will be described in the following specific implementations with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Embodiments of the present invention are described in detail in the following with reference to the accompanying drawings:

FIG. 1 is a schematic diagram of a miniature circuit breaker according to an embodiment of the present invention.

FIG. 2 is a schematic exploded view of a housing of the miniature circuit breaker from a viewing angle according to an embodiment of the present invention.

FIG. 3 is a schematic exploded view of the housing of the miniature circuit breaker from another viewing angle according to an embodiment of the present invention.

FIG. 4 is a schematic view of the inside of the housing viewed from a first phase circuit according to an embodiment of the present invention.

FIG. 5 is a schematic view of the inside of the housing viewed from a second phase circuit according to an embodiment of the present invention.

FIG. 6 is a schematic view of an operating mechanism from a viewing angle according to an embodiment of the present invention.

FIG. 7 is a schematic view of the operating mechanism from another viewing angle according to an embodiment of the present invention.

Description of the reference numerals:

[0017] 1. housing; 11. first half housing; 12. second half housing; 121. support wall; 122. pivoting shaft; 13. intermediate casing; 131. first casing portion; 133. recess; 132. second casing portion; 2. operating mechanism; 21. handle; 211. tooth structure; 212. handle torsional spring; 213. orifice; 22. connecting rod; 23. latch; 24. trip bar; 241. trip bar torsional spring; 25. contact support frame; 251. contact support frame torsional spring; 252. first pin; 253. second pin; 254. connecting pin; 26. indicator plate; 261. arc-shaped slot; 3. first phase circuit; 31. first movable contact; 311. first movable contact torsional spring; 312. first arc-shaped segment; 32. first stationary contact; 33. first wiring terminal; 331. wire; 34. second wiring terminal; 341. wire; 35. arc extinguishing chamber; 36. first current transformer; 4. second phase circuit; 41. second movable contact; 411. second movable contact torsional spring; 412. second arc-shaped segment; 42. second stationary contact; 43. third wiring terminal; 44. fourth wiring terminal; 441. wire; 5. closing actuating mechanism; 51. closing coil; 52. closing armature; 521. rack; 53. transmission gear; 531. first gear; 532. second gear; 6. opening actuating mechanism; 61. opening armature; 62. first opening coil; 63. second opening coil; 7. control circuit board; 8. test assembly; 81. button; 82. wire; 83. elastic member; 84. resistor; 9. second current transformer.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] A schematic scheme of the miniature circuit breaker disclosed in the present invention is described in detail below with reference to the accompanying drawings. Although the accompanying drawings are provided to present some implementations of the present invention, the accompanying drawings do not need to be drawn according to the size of the specific implementation schemes, and certain features can be enlarged, removed, or locally exploded to better illustrate and explain the disclosure of the present invention. Part of the components in the accompanying drawings can be positionally adjusted according to actual requirements without affecting the technical effect. In the description, the term "in the accompanying drawings" or similar terms do not necessary refer to all of the accompanying drawings or examples.

[0019] Some directional terms used in the following to describe the accompanying drawings, such as "in", "out", "upper", and "lower," and other directional terms are construed as having normal meanings thereof and refer to those directions involved when the accompanying drawings are viewed normally. Unless otherwise specified, the directional terms in the description are substantially in accord with conventional directions understood by those skilled in the art.

[0020] The terms "first", "first one," "second", "second one" and similar terms used in the present invention do

not indicate any sequence, number, or importance in the present invention, and are used only to distinguish one component from other components.

[0021] FIGS. 1-7 show a miniature circuit breaker according to embodiments of the present invention. As shown in FIG. 1, the miniature circuit breaker accommodates an operating mechanism, two-phase (1P+N) circuits, and corresponding opening and closing actuating mechanisms, controller, current detection device, etc. in an interior space defined by a single housing 1. In this way, the miniature circuit breaker module shown in FIG. 1 can realize short circuit, overload, and leakage protection functions and can be operated remotely. The width H of the miniature circuit breaker module is defined as: $H \leq 18$ millimeters (i.e., less than or equal to 1 modulus), thereby achieving a simple structure and greatly reducing the volume. In addition, the miniature circuit breaker has only four wiring terminals, thereby optimizing wire connection operations and ensuring safety.

[0022] In the embodiment shown in FIGS. 2 and 3, the housing 1 consists of two opposite half housings, i.e., a first half housing 11 and a second half housing 12 that are detachably connected, and an intermediate casing 13 between the two opposite half housings. The first half housing 11, the second half housing 12, and the intermediate casing 13 collectively surround and define the interior space of the housing 1, and the intermediate casing 13 divides the interior space into two compartments for respective arrangement of the two-phase circuits.

[0023] The interior construction of the miniature circuit breaker is described below with reference to the embodiments shown in FIGS. 4-7, wherein FIG. 4 is a schematic view viewed from a first phase (e.g., P phase) circuit, FIG. 5 is a schematic view viewed from a second phase (e.g., N phase) circuit, and the two circuits are respectively located in the compartments separated by the intermediate casing 13. In the illustrated embodiment, the miniature circuit breaker includes an operating mechanism 2, a first phase circuit 3, a second phase circuit 4, a closing actuating mechanism 5, an opening actuating mechanism 6, and a control circuit board 7. The operating mechanism 2 includes a handle 21, and a latch 23 and a trip bar 24 operable with the handle 21. Referring to FIGS. 6 and 7, the handle 21 has an orifice 213 through which a shaft rod connected to the housing 1 passes, whereby the handle 21 is rotatable about the shaft rod. A portion of the handle 21 extends out of the housing 1 for manual opening and closing operations. A handle torsional spring 212 is arranged between the handle 21 and the housing 1. The handle torsional spring 212 constantly applies, to the handle 21, a force that makes the handle rotate in a first direction (the clockwise direction in FIG. 4, and the counterclockwise direction in FIG. 5) or have a tendency to rotate in the first direction. Once the handle 21 rotates in the first direction, it means that the miniature circuit breaker is opened.

[0024] The handle 21 is connected to the latch 23 by mean of a connecting rod 22, the latch 23 is rotatably connected to a contact support frame 25 by mean of a connecting pin 254, and the contact support frame 25 is rotatably connected to a pivoting shaft 122 of the housing 1. A contact support frame spring 251 is arranged between the contact support frame 25 and a support wall 121 formed on the second half housing 12 of the housing 1. The contact support frame spring 251 constantly applies, to the contact support frame 25, a force that makes the contact support frame rotate in a second direction (the counterclockwise direction in FIG. 4, and the clockwise direction in FIG. 5) or have a tendency to rotate in the second direction. Once the contact support frame 25 rotates in the second direction, it means that the miniature circuit breaker is opened. The trip bar 24 is pivotally connected to the contact support frame 25. In the illustrated embodiment, a pivoting axis of the trip bar 24 coincides with a pivoting axis of the contact support frame 25. During closing of the miniature circuit breaker, the trip bar 24 is constantly locked together with the latch 23. Once a current anomaly occurs in the circuit, e.g., overload, short circuit, or leakage, the trip bar 24 is driven by the opening actuating mechanism to be unlocked from latch 23, thereby allowing opening of the miniature circuit breaker. A trip bar torsional spring 241 is connected between the contact support frame 25 and the trip bar 24, and constantly applies, to the trip bar 24, a force that makes the trip bar rotate in the first direction (the clockwise direction in FIG. 4, and the counterclockwise direction in FIG. 5) or have a tendency to rotate in the first direction. By means of the trip bar torsional spring 241, the trip bar 24 unlocked from the latch 23 can be reset and relocked (re-fastened) with the latch 23.

[0025] In order to clearly indicate the current opening/closing status of the miniature circuit breaker to the outside, the operating mechanism 2 is provided with an indicator plate 26. The indicator plate 26 is rotatably connected to the shaft rod arranged at the housing 1, and an arc-shaped slot 261 is formed on the body of the indicator plate 26. The connecting pin 254 for connecting the latch 23 to the contact support frame 25 passes through the arc-shaped slot 261 and is movable in the arc-shaped slot 261. Therefore, during opening and closing of the miniature circuit breaker, the indicator plate 26 is rotated such that different parts thereof are aligned with an opening formed on the housing 1. The different parts can be marked with "open", "on", "close", "off", or other characters, or marked with different colors, such as blue and red, so as to transmit opening and closing status information to the outside.

[0026] The closing actuating mechanism 5 that drives the action of the operating mechanism 2 is mounted in the interior space of the housing 1. Referring to FIGS. 2-3, in order to facilitate mounting of the closing actuating mechanism 5, the intermediate casing 13 is provided with a recess 133, and the closing actuating mechanism 5 is mounted in the recess 133. In the illustrated embodiment, the closing actuating mechanism 5 is selected from electromagnetic closing mechanisms, and includes a closing

coil 51 arranged in the recess and a closing armature 52 surrounded by the closing coil 51. The closing armature 52 is connected to and drives the handle 21 by means of a transmission mechanism, and the closing coil 51 is electrically connected to the control circuit board 7 mounted on the second half housing 12. The control circuit board 7 supplies power to the closing coil 51, so as to drive the closing armature 52 to move, e.g., retract into the closing coil 51, thereby driving the handle 21 to move.

[0027] In an embodiment, the closing armature 52 is connected to the handle 21 by means of a gear rack transmission mechanism. For example, a rack 521 is mounted on the closing armature 52, the handle 21 has a tooth structure 211 arranged along the circumference thereof, and a transmission gear 53 is arranged between the rack 521 and the tooth structure 211. The movement of the closing armature 52 drives, by means of the gear rack transmission mechanism, the handle 21 to rotate in the second direction, and the rotation of the handle 21 drives, by means of the connecting rod 22, the latch 23, the trip bar 24, and the contact support frame 25 to rotate together. The contact support frame 25 rotates in the first direction, thereby driving, by means of a first movable contact torsional spring 311, closing of a first movable contact 31 and a first stationary contact 32, and driving, by means of a second movable contact torsional spring 411, closing of a second movable contact 41 and a second stationary contact 42.

[0028] In an embodiment, the transmission gear 53 may be composed of two gears connected together and having different numbers of teeth, i.e., a first gear 531 engaging with the rack 521 and a second gear 532 engaging with the tooth structure of the handle 21. The two-gear structure can reduce a driving force required by the closing actuating mechanism during automatic closing, thereby reducing power consumption of the closing coil.

[0029] The two-phase circuits operable by the operating mechanism 2 are arranged adjacent to each other in the housing 1. According to the embodiment as shown in FIG. 4, the first phase circuit 3 may also be referred to as a P phase, and includes the first movable contact 31, the first stationary contact 32, a first wiring terminal 33, and a second wiring terminal 34. The first wiring terminal 33 is electrically connected to the first stationary contact 32 by means of a wire 331 to form a primary circuit. A first current transformer 36 is sleeved on the wire 331 and is located between the first wiring terminal 33 and the first stationary contact 32. The first current transformer 36 is electrically connected to the control circuit board 7 located in the interior space of the housing 1, thereby sending measured current information of the primary circuit to the control circuit board 7. The control circuit board 7 is mounted on the second half housing 12 and located between the second half housing 12 and the intermediate casing 13, and the intermediate casing 13 may be provided with a clearance opening to facilitate mounting of the first current transformer 36. In an embodiment, the intermediate casing 13 may consist of a first casing portion 131 and a second casing portion 132 that are detachably provided, and the first casing portion 131 and the second casing portion 132 surround and define the clearance opening and the recess 133.

[0030] The first movable contact 31 is pivotally connected to the contact support frame 25, and the first movable contact torsional spring 311 is connected between the contact support frame 25 and the first movable contact 31. The first movable contact torsional spring 311 applies, to the first movable contact 31, a force that makes the first movable contact rotate in the first direction (the clockwise direction in FIG. 4, and the counterclockwise direction in FIG. 5) or have a tendency to rotate in the first direction. Once rotating in the first direction, the first movable contact 31 approaches and is connected to the first stationary contact 32 to achieve closing of the first phase circuit 3.

[0031] The opening actuating mechanism 6 is arranged between the first movable contact 31 and the second wiring terminal 34. According to the embodiments of the present invention, the opening actuating mechanism 6 has a dual protection function, i.e., overload protection and short circuit protection. As shown, the opening actuating mechanism 6 employs an electromagnetic trip mechanism, wherein a first opening coil 62 for overload protection surrounds an opening armature 61, the first opening coil 62 is electrically connected to the control circuit board 7, a second opening coil 63 for shortcircuit protection surrounds the first opening coil 62, and the second opening coil 63 is electrically connected to the second wiring terminal 34 by means of the wire 341. In this way, once the first current transformer 36 detects an overload current, the control circuit board 7 supplies power to the first opening coil 62, driving the opening armature 61 to move towards the trip bar 24 and apply an impact on the trip bar 24, making the trip bar 24 unlocked from the latch 23, and thus allowing opening of the first movable contact 31 and the first stationary contact 32. Once a loop is short-circuited, for example, the first phase circuit and the second phase circuit form a short circuit connection, a current flowing in the second opening coil 63 electrically connected to the second wiring terminal 34 makes the second opening coil 63 generate a magnetic field sufficient to drive the opening armature 61, such that the opening armature 61 moves and applies an impact on the trip bar 24, making the trip bar 24 unlocked from the latch 23, and thus allowing opening of the first movable contact 31 and the first stationary contact 32.

[0032] In an embodiment, two overload current thresholds or threshold ranges are preset, wherein the first threshold or threshold range is less than the second threshold or threshold range. When an overload current detected by the first current transformer 36 is less than or equal to the first threshold or within the first threshold range, it means that the overload current is relatively small, in which case the power supply from the control circuit board 7 to the first opening coil 62 can be delayed

for a preset time to realize a delayed opening function. When an overload current detected by the first current transformer 36 is equal to or greater than the first threshold or within the second threshold range, it means that the overload current is relatively large, in which case power can be supplied from the control circuit board 7 to the first opening coil 62 almost immediately to realize a short-time fast opening function. In addition, remote operation opening may be achieved by means of the first opening coil 62 and the opening armature 61 connected to the control circuit board 7.

[0033] An embodiment of the second phase circuit 4 (e.g., N phase) is shown in FIG. 5. As shown, the second phase circuit 4 includes a third wiring terminal 43, the second stationary contact 42 electrically connected to the third wiring terminal 43, the second movable contact 41, and a fourth wiring terminal 44 electrically connected to the second movable contact 41 by means of a wire 441. Similar to the first movable contact, the second movable contact 41 is pivotally connected to the contact support frame 25, and the first movable contact and second movable contact are located on two opposite sides of the contact support frame, respectively. The second movable contact torsional spring 411 is connected between the second movable contact 41 and the contact support frame 25 and constantly applies, to the second movable contact 41, a force that makes the second movable contact rotate in the first direction (the clockwise direction in FIG. 4, and the counterclockwise direction in FIG. 5) or have a tendency to rotate in the first direction. Once rotating in the first direction, the second movable contact 41 approaches and is connected to the second stationary contact 42 to achieve closing of the second phase circuit 4.

[0034] In an embodiment, the opening of the first phase circuit 3 and the opening of second phase circuit 4 are asynchronous, and by making the overtravel of the first movable contact 31 less than the overtravel of the second movable contact 41, the opening of the first movable contact 31 and the first stationary contact 32 may occur prior to the opening of the second movable contact 41 to the second stationary contact 42.

[0035] The overtravel of the first movable contact 31 being less than the overtravel of the second movable contact 41 may be achieved by reasonably designing cooperation relationships between the contact support frame 25 with respect to the first movable contact 31 and second movable contact 41. In the illustrated embodiment, the contact support frame 25 is provided with a first pin 252 on a side face where the first movable contact 31 is mounted and a second pin 253 on a side face where the second movable contact 41 is mounted, and an outer diameter of the first pin 252 is greater than an outer diameter of the second pin 253. Pivoting axes of the first movable contact 31 and the second movable contact 41 coincide. The first movable contact 31 has a first arc-shaped segment 312 extending along an outer circumferential surface of the first pin 252, the second movable contact 41 has a second arc-shaped segment 412 extending along an outer circumferential surface of the second pin 253, and the arc angle of the first arc-shaped segment 312 is substantially the same as the arc angle of the second arc-shaped segment 412. In this way, the overtravel of the first movable contact 31 is less than the overtravel of the second movable contact 41, thereby enabling the opening of the first movable contact 31 and the first stationary contact 32 to occur prior to the opening of the second movable contact 41 and the second stationary contact 42.

[0036] In addition to the reasonable design of the cooperation relationships of the contact support frame 25 with respect to the first movable contact 31 and the second movable contact 41, a person skilled in the art could also conceive of other ways to configure the overtravel of the first movable contact 31 to be less than the overtravel of the second movable contact 41. For example, in an embodiment not shown, the overtravel of the first movable contact 31 being less than the overtravel of the second movable contact 41 can be achieved by a design in which the force applied by the first movable contact torsional spring 311 to the first movable contact 31 is different from the force applied by the second movable contact torsional spring 411 to the second movable contact 41.

[0037] Since the opening of the second phase circuit 4 occurs later than the opening of the first phase circuit 3, an arc extinguishing chamber 35 may be arranged for the first phase circuit 3 only. As shown in FIG. 4, the arc extinguishing chamber 35 is arranged directly below the first stationary contact 32. Blocking plates (not shown) extending to the arc extinguishing chamber may be arranged at two opposite sides of the first stationary contact 32, ensuring that an arc is directed towards the arc extinguishing chamber 35.

[0038] Referring to FIGS. 4 and 5, the first phase circuit 3 and the second phase circuit 4 are provided with a second current transformer 9 for leakage protection. The wire 341 connecting the second wiring terminal 34 and the opening actuating mechanism 6 and the wire 441 connecting the fourth wiring terminal 44 and the second movable contact 41 both pass through the second current transformer 9. The second current transformer 9 is electrically connected to the control circuit board 7 to send a signal to the control circuit board 7 upon detection of a leakage current, and based on the signal, the control circuit board 7 controls the opening actuating mechanism 6 to drive the trip bar 24 to trip.

[0039] The miniature circuit breaker according to this embodiment is further provided with a test assembly 8 for leakage tests. As shown in FIGS. 4 and 5, a button 81 of the test assembly 8 is inserted in an opening of the housing 1 and is movable relative to the housing 1, and a conductive structure electrically connected to the fourth wiring terminal 44 is provided on a side of the button 81 facing the housing 1. A wire 82 extends in the interior space of the housing 1 and is electrically connected to

the control circuit board 7. Moreover, the wire 82 is electrically connected to the wire 331/first wiring terminal 33. A resistor 84 is provided at an end portion of the wire 82 facing the button 81, and the resistor 84 is in the interior space of the housing 1, and is spaced apart from the button 81 and the conductive mechanism by a specific distance under normal conditions. When being pressed, the button 81 drives the conductive mechanism to form a short circuit connection with the resistor 84 and the wire 82, and a leakage current would be generated since the conductive mechanism is electrically connected to the fourth wiring terminal 44 by means of a wire. When the control circuit board 7 detects a leakage signal, the control circuit board 7 supplies power the first opening coil 62, driving the opening armature 61 to move towards the trip bar 24 and apply an impact on the trip bar 24, making the trip bar 24 unlocked from the latch 23, allowing the opening of the first movable contact 31 and the first stationary contact 32, and thereby completing the leakage test.

[0040] In the illustrated embodiment, an elastic member 83 (e.g., a torsional spring) is arranged on the housing 1 and supports the button 81. The elastic member 83 constantly applies, to the button 81, a force that makes the button move in a direction away from the housing 1 or have a tendency to move in the direction away from the housing 1. In this way, only when the button 81 is pressed toward the interior of the housing 1 can the button 81 drive the conductive structure to form a short circuit connection with the resistor 84 and conduct the circuit. Once the pressing force is withdrawn, the button 81 immediately moves away from the resistor under the action of the elastic member 83, thus switching off the circuit. In an embodiment, the function of the conductive structure is achieved by electrically connecting the elastic member 83 to the fourth wiring terminal 44 by means of a wire.

[0041] It should be appreciated that although the description is presented according to each embodiment, each embodiment does not necessarily include only one independent technical solution. The presentation manner of the description is merely for clearness, and those skilled in the art should regard the description as a whole, and the technical solutions in the embodiments can also be appropriately combined to form other implementations comprehensible by those skilled in the art.

[0042] What is described above is merely exemplary specific implementations of the present invention, but is not intended to limit the scope of the present invention. Any equivalent change, modification, or combination made by those skilled in the art without departing from the conception and principle of the present invention shall fall within the protection scope of the present invention.

Claims

1. A miniature circuit breaker, **characterized by** comprising:

a housing (1) defining an interior space;
a control circuit board (7), disposed in the interior space;
an operating mechanism (2) comprising a handle (21), a latch (23) connected to the handle (21), a trip bar (24) capable of being locked with or unlocked from the latch (23), and a contact support frame (25) supporting the latch (23) and the trip bar (24);
a first phase circuit (3) comprising a first wiring terminal (33), a first stationary contact (32) electrically connected to the first wiring terminal (33), a first movable contact (31) pivotally connected to the contact support frame (25), and a second wiring terminal (34);
a second phase circuit (4) comprising a third wiring terminal (43), a second stationary contact (42) electrically connected to the third wiring terminal (43), a second movable contact (41) pivotally connected to the contact support frame (25), and a fourth wiring terminal (44) electrically connected to the second movable contact (41);
a closing actuating mechanism (5), electrically connected to the control circuit board (7) and connected to and driving the operating mechanism (2);
a first current detection device, configured to detect a current flowing through the first stationary contact (32), and electrically connected to the control circuit board (7);
a second current detection device, configured to detect a current flowing through the second wiring terminal (34) and the fourth wiring terminal (44), and electrically connected to the control circuit board (7); and
an opening actuating mechanism (6), electrically connected to the second wiring terminal (34) and the control circuit board (7), and configured to selectively drive the trip bar (24) to be unlocked from the latch (23) based on current information detected by the first current detection device and the second current detection device.

2. The miniature circuit breaker according to claim 1, wherein the first wiring terminal (33) is connected to the first stationary contact (32) by means of a wire (331), and the first current detection device is a first current transformer (36) sleeved on the wire (331).

3. The miniature circuit breaker according to claim 1, wherein the second wiring terminal (34) is connected to the opening actuating mechanism (6) by means of a wire (341), the fourth wiring terminal (44) is connected to the second movable contact (41) by means of a wire (441), and the second current detection device is a second current transformer (9) sleeved

on the two wires (341, 441).

4. The miniature circuit breaker according to claim 1, wherein the opening actuating mechanism (6) comprises:

an opening armature (61), movably mounted in the interior space of the housing (1); and
a first opening coil (62), surrounding the opening armature (61) and electrically connected to the control circuit board (7);
wherein the control circuit board (7) is configured to control the opening armature (61) to move based on current conditions detected by the first current detection device and/or the second current detection device, so as to drive the trip bar (24) to be unlocked from the latch (23).

5. The miniature circuit breaker according to claim 1, wherein the opening actuating mechanism (6) comprises:

an opening armature (61), movably mounted in the interior space of the housing (1); and
a second opening coil (63), surrounding the opening armature (61) and electrically connected to the second wiring terminal (34), wherein the second opening coil (63) drives the opening armature (61) to move based on current conditions, so as to drive the trip bar (24) to be unlocked from the latch (23).

6. The miniature circuit breaker according to claim 1, wherein the housing (1) comprises a first half housing (11) and a second half housing (12) disposed opposite to each other, and an intermediate casing (13) located between the first half housing (11) and the second half housing (12), and the closing actuating mechanism (5) is supported by the intermediate casing (13) and comprises:

a closing coil (51), disposed at the intermediate casing (13); and
a closing armature (52), movably passing through the closing coil (51) and connected to and driving the handle (21).

7. The miniature circuit breaker according to claim 6, wherein the control circuit board (7) is secured to the intermediate casing (13) at a location adjacent to the first wiring terminal (33) and the first current detection device, and a clearance opening corresponding to the first current detection device is formed in the intermediate casing (13).

8. The miniature circuit breaker according to claim 1, wherein the contact support frame (25) is pivotally mounted on the housing (1), and the first movable contact (31) and the second movable contact (41) are pivotally mounted on the contact support frame (25), wherein overtravel of the first movable contact (31) is less than overtravel of the second movable contact (41), and an arc extinguishing chamber (35) corresponding to the first stationary contact (32) is arranged in the interior space.

9. The miniature circuit breaker according to claim 1, wherein the operating mechanism (2) further comprises an indicator plate (26) pivotally mounted on the housing (1), the indicator plate (26) has an arc-shaped slot (261), and a connecting pin (254) pivotally connecting the latch (23) to the contact support frame (25) is inserted in the arc-shaped slot (261) and is movable in the arc-shaped slot (261).

10. The miniature circuit breaker according to claim 1, further comprising a test assembly (8), the test assembly (8) comprising:

a button (81), movably mounted at the housing (1); and
a conductive structure, provided on the button (81) and electrically connected to the fourth wiring terminal (44); and a resistor (84), electrically connected to the control circuit board (7) and the first wiring terminal (33);
wherein when the button (81) is moving towards the housing (1), the conductive structure is capable of being electrically connected to the resistor (84).

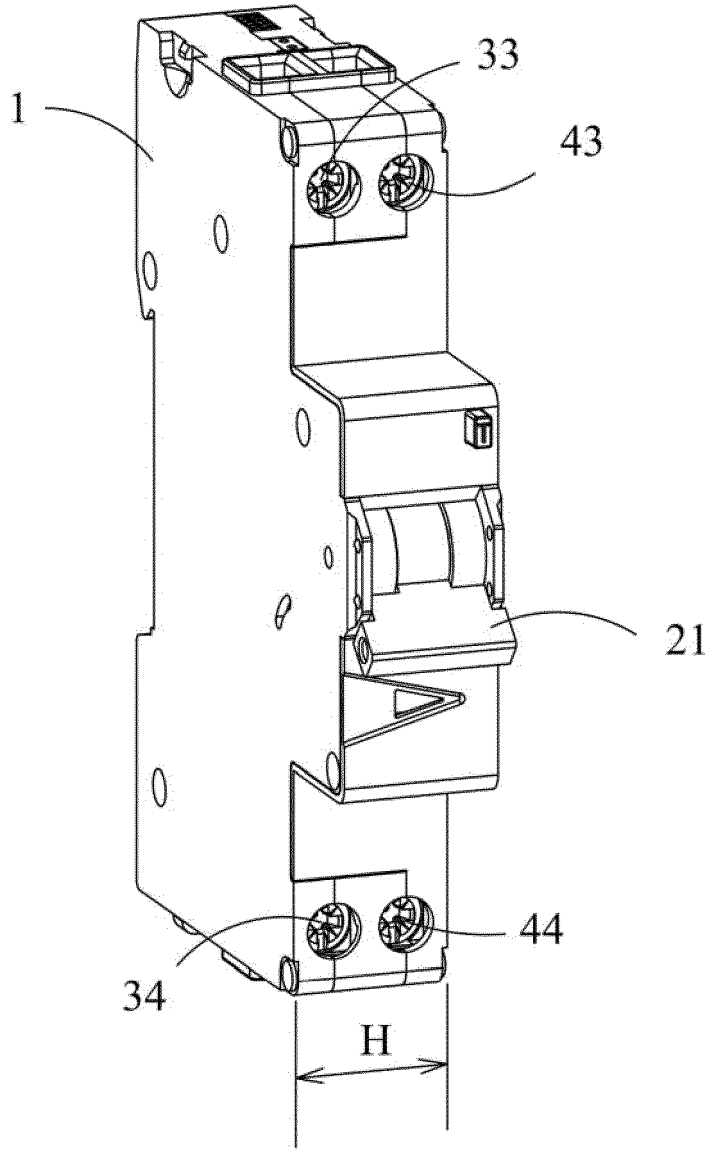


FIG. 1

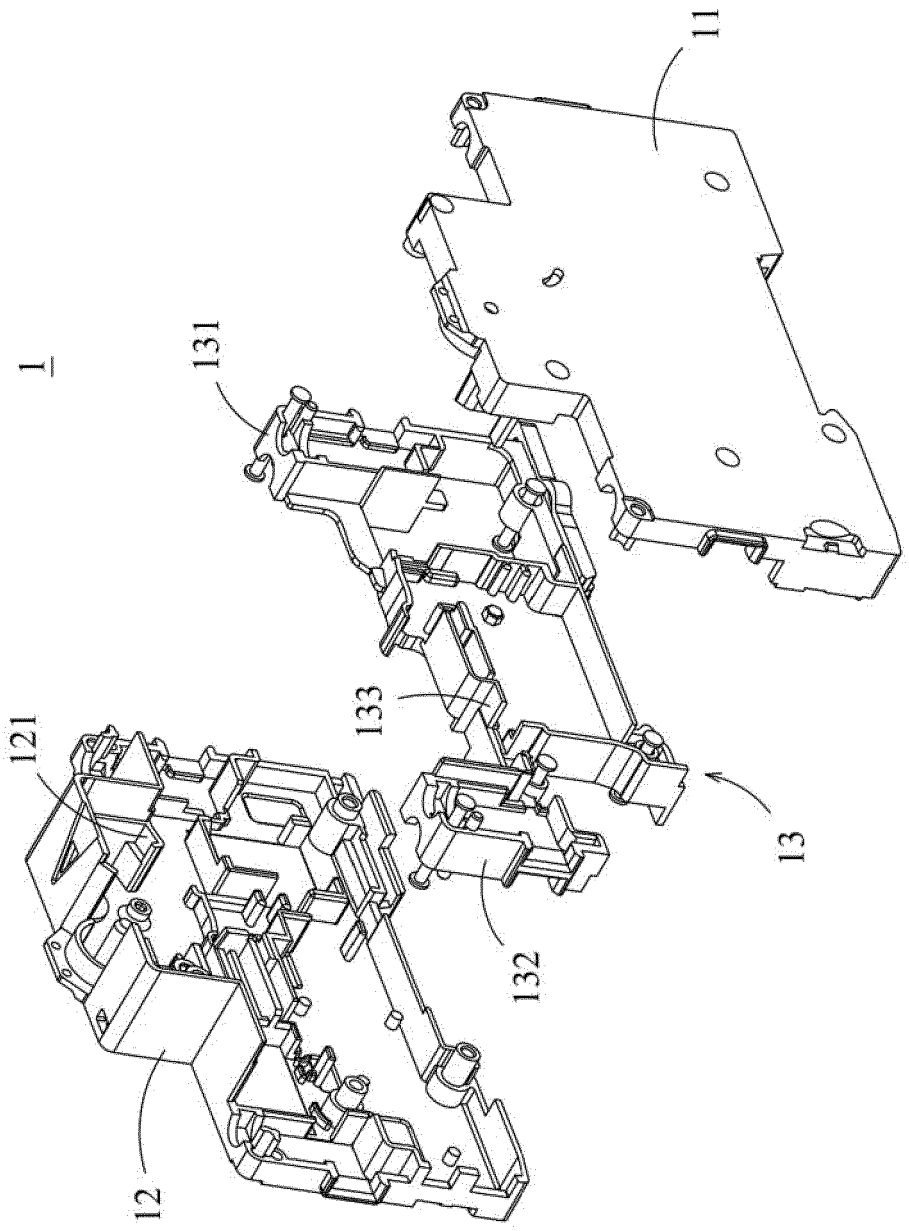
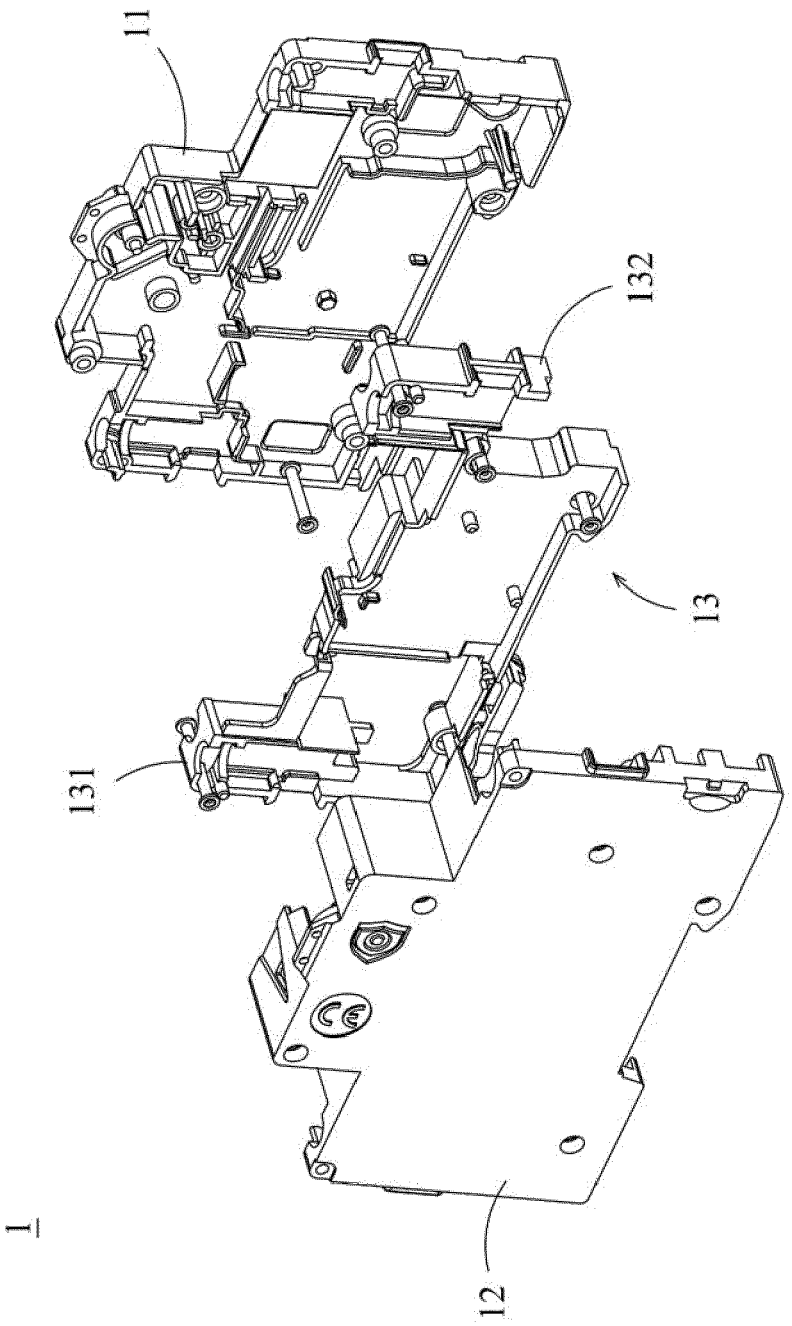


FIG. 2



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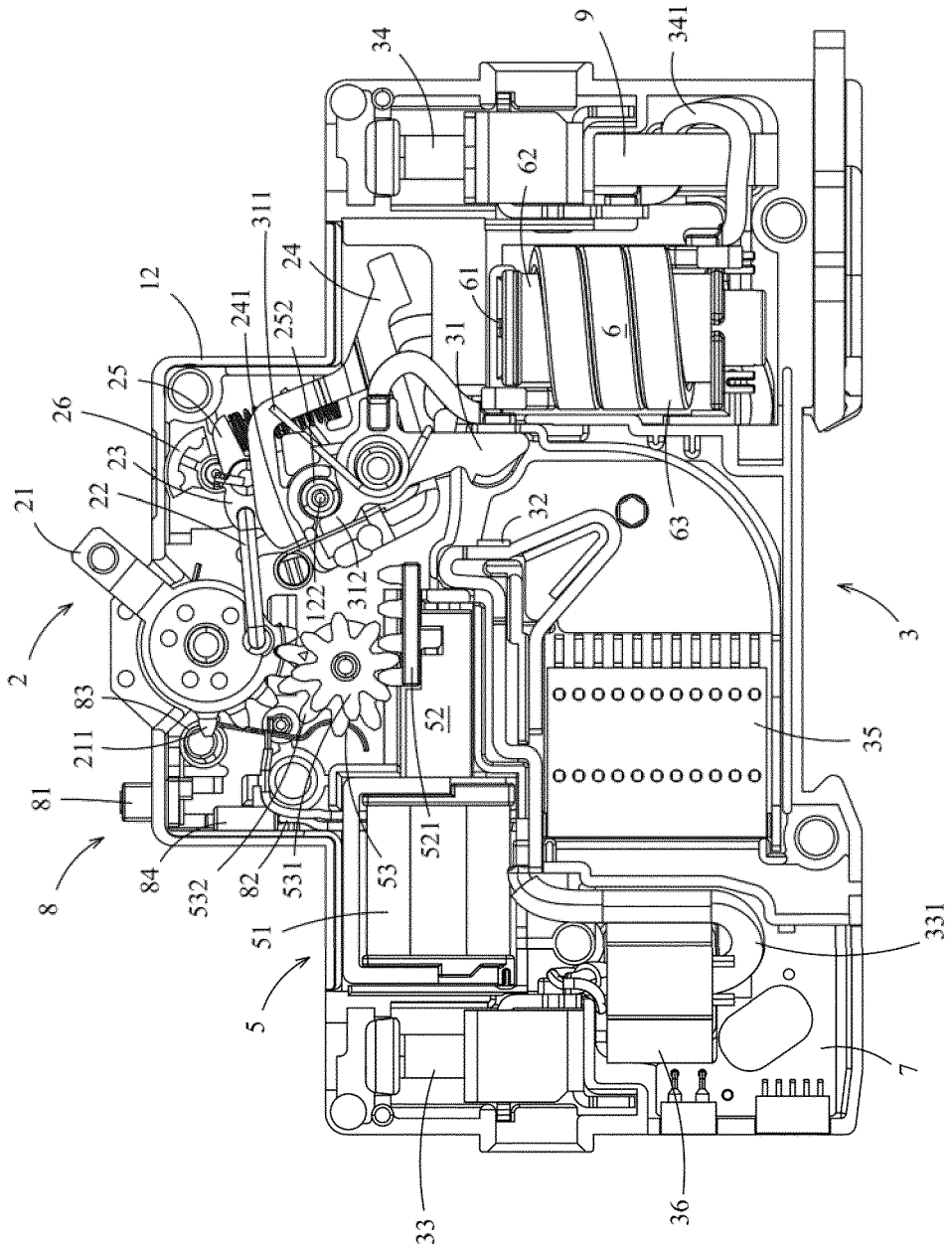
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FIG. 4

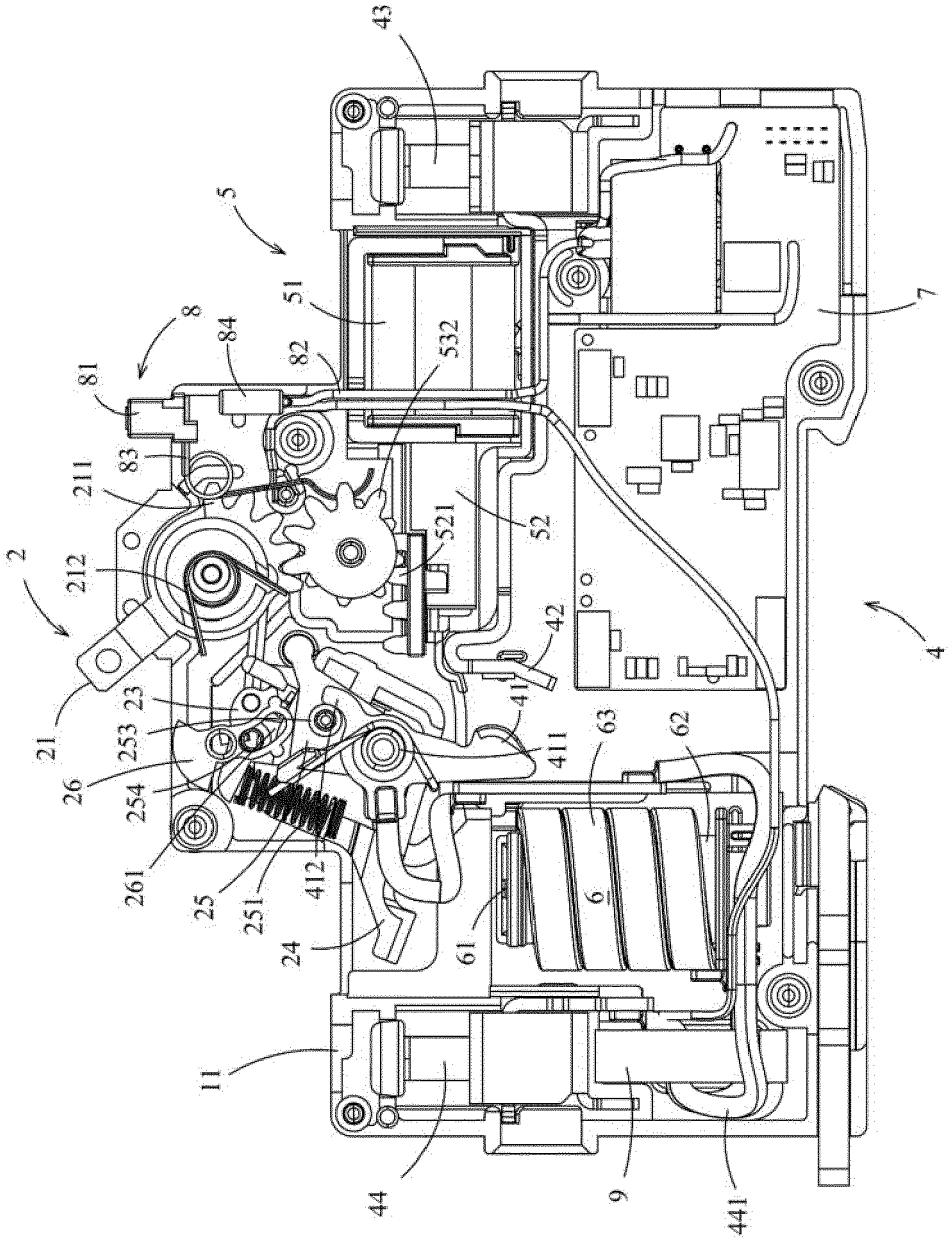
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FIG. 5

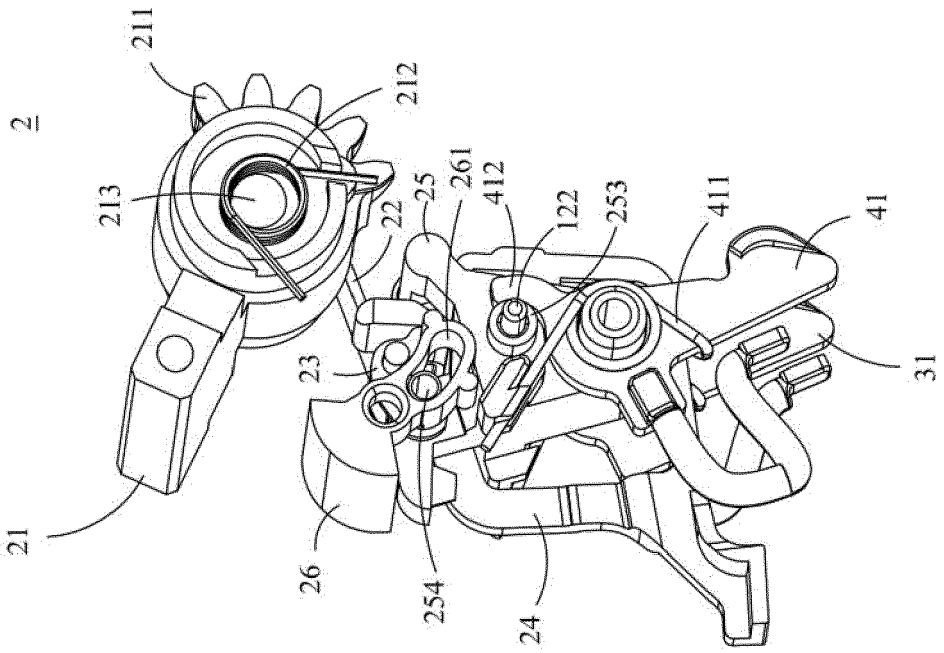
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FIG. 7

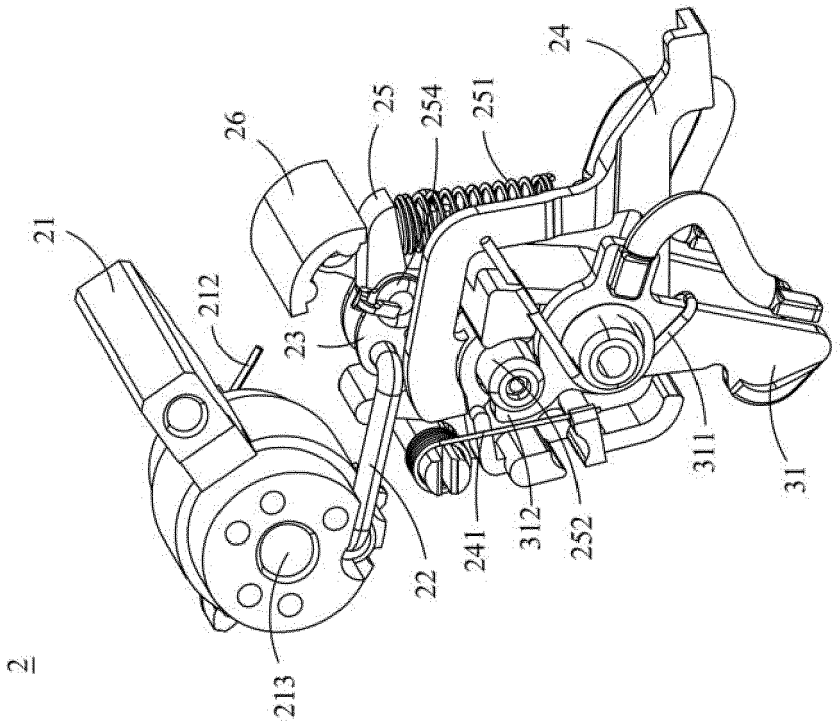
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FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 8269

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2007/126234 A1 (LEE HAN SIK [KR]) 8 November 2007 (2007-11-08) * the whole document *	1-10	INV. H01H71/52 H01H71/68 H01H83/14

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 July 2023	Arenz, Rainer

CATEGORY OF CITED DOCUMENTS

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19-07-2023

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WO 2007126234 A1	08-11-2007	KR 100718530 B1	18-05-2007
		WO 2007126234 A1	08-11-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82